Entergy

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Anthony J. Vitale
Site Vice President

NL-19-048

May 14, 2019

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Stop O-P1-17
Washington, D.C. 20555-0001

Subject: Licensee Event Report # 2019-001-00 "Automatic Reactor Trip as a Result of a Turbine-Generator Trip Due to a Loss of Generator Excitation"
Indian Point Unit No. 2
Docket No. 50-247
DPR-26

Dear Sir or Madam:

Pursuant to 10 CFR 50.73(a)(1), Entergy Nuclear Operations Inc, hereby provides Licensee Event Report (LER) 2019-001-00. The attached LER identifies an event where the reactor was automatically tripped, which is reportable under 10 CFR 50.73(a)(2)(iv)(A). As a result of the reactor trip, the Auxiliary Feedwater System was actuated, which is also reportable under 10 CFR 50.73(a)(2)(iv)(A). This condition was recorded in the Entergy Corrective Action Program as Condition Report CR-IP2-2019-01298.

There are no commitments made or revised in this letter. Should you have any questions regarding this matter, please contact Mr. Robert Walpole, Manager, Regulatory Assurance, Indian Point Energy Center at (914) 254-6710.

Sincerely,

AJV/trj

cc: Mr. David Lew, Regional Administrator, NRC Region I
NRC Resident Inspector's Office
Ms. Bridget Frymire, New York State Public Service Commission

IE22
NRR

NRC FORM 366 (04-2018) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 03/31/2020

Estimated burden per response to comply with this mandatory collection request: 80 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Information Services Branch (T-2 F43), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by e-mail to Infocollects.Resource@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

LICENSEE EVENT REPORT (LER)

(See Page 2 for required number of digits/characters for each block)

(See NUREG-1022, R.3 for instruction and guidance for completing this form http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1022/r3/)

1. Facility Name	2. Docket Number	3. Page
INDIAN POINT UNIT 2	05000-247	1 OF 4

4. Title

Loss of Excitation Main Generator Trip

5. Event Date			6. LER Number			7. Report Date			8. Other Facilities Involved	
Month	Day	Year	Year	Sequential Number	Rev No.	Month	Day	Year	Facility Name	Docket Number
										05000
3	15	2019	2019	- 001	- 00	5	14	2019	Facility Name	Docket Number
										05000

9. Operating Mode	11. This Report is Submitted Pursuant to the Requirements of 10 CFR §: *(Check all that apply)*			
1	☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
	☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
	☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
	☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☒ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
10. Power Level	☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
	☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
100	☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(C)	☐ 73.77(a)(1)
	☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(D)	☐ 73.77(a)(2)(i)
	☐ 20.2203(a)(2)(vi)	☐ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(vii)	☐ 73.77(a)(2)(ii)
		☐ 50.73(a)(2)(i)(C)	☐ Other (Specify in Abstract below or in NRC Form 366A)	

12. Licensee Contact for this LER

Licensee Contact	Telephone Number (Include Area Code)
Emily Cioffi, System Engineer	914-254-6839

13. Complete One Line for each Component Failure Described in this Report

Cause	System	Component	Manufacturer	Reportable To ICES	Cause	System	Component	Manufacturer	Reportable To ICES
X	TL	EXC	G080	Y					

14. Supplemental Report Expected	15. Expected Submission Date	Month	Day	Year
☐ Yes (If yes, complete 15. Expected Submission Date) ☒ No				

ABSTRACT

On March 15, 2019 at approximately 1300 hours Eastern Standard Time, Indian Point Unit 2 experienced an automatic reactor trip on a turbine trip, which was in response to a main generator trip. The main generator trip was initiated by actuation of the generator Protection System due to a main generator loss of excitation.

All control rods fully inserted and all required safety systems functioned properly. The plant was stabilized in hot standby with decay heat being removed by the main condenser. The Auxiliary Feedwater System automatically started as expected on steam generator low level to provide feedwater flow to the steam generators. The plant was stabilized in hot standby with decay heat being removed by the main condenser. The direct cause of this event was a failure of both diodes in the C-phase middle diode stack of the 24 Rectifier. The root cause of this event was the fact that the power diode test method was unable to detect component degradation.

This event had no effect on the public health and safety. This event was reported to the Nuclear Regulatory Commission on March 15, 2019 under 10 CFR 50.72(b)(3)(iv)(A) and 10 CFR 50.72(b)(2)(iv)(B) as an event that resulted in the automatic actuation of the Reactor Protection System when the reactor is critical and a valid actuation of the Auxiliary Feedwater System.

LICENSEE EVENT REPORT (LER)
CONTINUATION SHEET

(See NUREG-1022, R.3 for instruction and guidance for completing this form http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1022/r3/)

1. FACILITY NAME	2. DOCKET NUMBER	3. LER NUMBER		
		YEAR	SEQUENTIAL NUMBER	REV NO.
Indian Point Unit 2	05000247	2019	- 001	- 00

NARRATIVE

On March 15, 2019 at approximately 1300 hours Eastern Standard Time, Unit 2 experienced a direct generator trip due to a loss of excitation. Upon initiation of a trip signal, the generator protection system will disconnect the generator from the offsite electric system. The generator output breakers in the Buchanan switchyard will open, and the generator field shorting breaker will close in order to rapidly de-energize the field. The loss of excitation was sensed by the 40 relay (Westinghouse model KLF-1), which actuated to protect the generator from becoming damaged due to operating when under-excited. The 40 relay actuated the time-delay (62BU1/AUX) relay, which after a one second delay, actuated the 86BU generator lockout relay. The 86BU initiated the generator trip and associated automatic actions, including turbine and reactor trip. This relaying scheme operated as designed, and was initiated by a valid, actual loss of field event.

There were no major activities going on at the time of the event; however, an "Exciter Cubicle Trouble" alarm was received in the Control Room approximately two minutes prior to the event. According to data recorded by the installed Disturbance Monitoring Equipment, the loss of excitation event lasted approximately twelve seconds and ultimately resulted in a collapse of the generator magnetic field.

Following the loss of excitation trip, the plant was stabilized in Mode 3 and the Main Generator was removed from service for troubleshooting. The troubleshooting efforts focused on the exciter cubicle, which had alarms prior to the event, the rectifier bridges, and the generator internal components that provide power to the field; all of these components can directly affect excitation and its control. A Failure Modes Analysis identified fifty-seven potential causes which were systematically tested or analyzed to confirm the direct cause, which was a failed diode stack that shorted the field. All remaining failure modes were eliminated prior to synchronization to the grid by various testing plans. A temporary monitoring system was installed to record valuable troubleshooting data in the case of a similar future event.

The troubleshooting and testing revealed that two diodes in the same stack (24 Rectifier, C-phase middle stack) had severely degraded to the point where they exhibited excessive leakage current. These diodes did not fully short. However, they had degraded sufficiently where they allowed excessive leakage current to pass through them in the reverse direction. Before the rectifier was returned to service, this degraded diode stack was replaced with a new diode stack that was tested and demonstrated satisfactory leakage characteristics.

All diodes will allow some amount of leakage current to flow when reverse-biased. The amount of leakage current is proportional to the applied reverse voltage, and is usually very small in relation. For every diode, there is also a reverse voltage at which the leakage current will sharply increase in relation to the applied reverse voltage. This phenomenon is known as "avalanche" breakdown, and is an inherent characteristic of all semiconductor junctions, including diodes and silicon controlled rectifiers. The breakdown voltage of a semiconductor junction is specified by the manufacturer, and is almost always selected to be greater than the maximum reverse voltage that the component will see in its application. As a semiconductor degrades, it is possible that breakdown may occur sooner than originally designed. The degraded diodes in the 24 Rectifier cabinet, C-phase middle stack were determined to be operating in their breakdown regions during the loss of field event.

This event had no effect on the public health and safety. This event was reported to the Nuclear Regulatory Commission on March 15, 2019 under 10 CFR 50.72(b)(3)(iv)(A) and 10 CFR 50.72(b)(2)(iv)(B) as an event that resulted in the automatic actuation of the Reactor Protection System when the reactor is critical and a valid actuation of the Auxiliary Feedwater System.

This event was recorded in the Indian Point Energy Center Corrective Action Program as CR-IP2-2019-01298.

CAUSE OF EVENT

The direct cause of this event was a failure of both diodes in the C-phase middle diode stack of the 24 Rectifier.

The root cause of this event was the fact that the power diode test method was unable to detect component degradation. The Corrective Action to Preclude Repetition for this root cause is the addition of a preventative maintenance strategy to properly test the power diodes in the GENERREX system.

The extent of condition identified that the Unit 3 Main generator is susceptible to a loss of field excitation. The Unit 3 generator is of a different design than the Unit 2 generator, and each have different excitation system schemes. The recent maintenance performed on the Unit 3 Exciter was reviewed to verify that no discrepancies exist that may lead to a loss of excitation event.

Extent of Cause is included in CR-IP2-2019-01298.

CORRECTIVE ACTIONS

The following corrective actions have been or will be performed under the Entergy Corrective Action program to address the causes of this event.

- Replaced failed diodes in the C-phase middle diode stack of the 24 Rectifier
- Replaced degraded diodes and silicon controlled rectifiers in 21 through 24 Rectifier Cabinets
- Create and issue a procedure that can be used to test the power diodes and silicon controlled rectifiers in the Unit 2 Main Generator rectifier cabinets with a Larkin M3K semiconductor tester or equivalent.
- Generate new preventative maintenance requests against the Unit 2 Main Generator Rectifier cabinets for improved diode and silicon controlled rectifiers testing using specialized test equipment.

EVENT ANALYSIS

This event had no effect on the public health and safety. This event was reported to the Nuclear Regulatory Commission on March 15, 2019 under 10 CFR 50.72(b)(2)(iv)(B) and 10 CFR 50.72(b)(3)(iv)(A) as an event that resulted in the automatic actuation of the Reactor Protection System when the reactor is critical and a valid actuation of the Auxiliary Feedwater System.

PAST SIMILAR EVENTS

A review was performed of the past three years (January 01, 2016 to May 07, 2019) for Indian Point Unit 2 and Unit 3 Licensee Event Reports that reported a reactor trip resulting from a failure of the Main Generator Excitation System, including the exciter and voltage regulator. The report identified the following:

1. December 20, 2017, Indian Point Unit 3 Licensee Event Report 2017-004-00 for an automatic reactor trip event that occurred on November 03, 2017. The reactor trip resulted from a turbine trip due to a trip of Generator Protection System Backup Generator Lockout Relay 86BU on loss of main generator excitation. The direct cause of this event was a failed Thyristor Firing Module drawer. The root cause of this event was determined to be a latent design vulnerability of the Unit 3 Automatic Voltage Regulator Thyristor Firing Module power supplies; in that shared common output nodes are not isolated after a failure.

2. April 16, 2018, Indian Point Unit 3 Licensee Event Report 2018-001-00 for an automatic reactor trip event that occurred on February 16, 2018. The reactor trip resulted from a turbine trip due to a trip of Generator Protection System due to a main generator loss of excitation. The direct cause of the loss of main generator excitation was the failure of an auctioneering diode in the Automatic Voltage Regulator Thyristor Firing Module (A) drawer power supply. The root cause was an improper refurbishment of obsolete Thyristor Module power supplies.

SAFETY SIGNIFICANCE

This event has no effect on the health and safety of the public.
There were no actual safety consequences for the event because the event was an uncomplicated automatic reactor trip with no other transients or accidents and the required primary safety systems performed as designed.

For this event, following the loss of excitation trip, the plant was stabilized in Mode 3. All automatic systems functioned as required. The auxiliary feedwater system actuated following the trip, as expected. All control rods fully inserted upon the trip, as expected. Required primary safety systems performed as designed when the reactor tripped. All safety systems functioned as intended and the direct generator trip is appropriately bounded by procedural governance.

There were no significant potential safety consequences of this event under reasonable and credible alternative conditions. The Reactor Protection System is designed to actuate a reactor trip for any anticipated combination of plant conditions including a direct reactor trip on turbine trip unless the reactor is below approximately 20 percent power.

The analysis in the Updated Final Safety Analysis Report Section 14.1.8, Loss of External Electrical Load, concludes that an immediate reactor trip on a turbine trip is not required for reactor protection. A reactor trip on a turbine trip is provided to anticipate probable plant transients and to avoid the resulting thermal transient. If the reactor is not tripped by a turbine trip, the over temperature delta temperature or over pressure delta temperature trip would prevent safety limits from being exceeded. This event was bounded by the analyzed event described in the Updated Final Safety Analysis Report Section 14.1.8. The response of the plant is evaluated for a complete loss of steam load or a turbine trip from full power without a direct reactor trip. The analysis shows that the plant design is such that there would be no challenge to the integrity of the RCS or main steam system and no core safety limit would be violated.